Global-scale temperature patterns and climate forcings over the past six centuries: A comment.

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The distinctive "hockey-stick" shape of the Mann et. al.[1] ("MBH98") temperature reconstruction (Figure 1a) results from two undisclosed and problematic methodological steps.

First, MBH98 stated that they used conventional principal components (PCs) to represent tree ring networks. Their Fortran software[2] indicates otherwise. They first standardized tree-ring chronologies (already standardized to a mean of 1000) on the 1902-1980 closing sub-segment; thus de-centering series with high 20th century growth rates. Then they calculated PCs using singular value decomposition on transformed data rather than on the covariance or correlation matrix. This overweights hockey-stick shaped series in the first principal component ("PC1"). We were able to consistently generate hockey-stick graphs by applying the MBH98 algorithm to random number series that simulate autocorrelated but trendless tree ring data. In 2003, Mann et al.[3] stated that the PC1 of their North American tree-ring network[4] (Figure 1b) was critical to their reconstruction. Figure 1c shows the PC1 from their data using a conventional PC algorithm. The hockey-stick disappears.

Under MBH98 methodology, 16 (of 70) proxies are overweighted and account for virtually all the variance of the North American PC1. All were high-altitude sites, mostly with cambial dieback ("strip bark") formation, showing very high 20th century growth rates. 15 were collected by the same researcher (Donald Graybill). Graybill and Idso[5] stated that these nonlinear growth rates could not be attributed to temperature and hypothesized direct CO_2 fertilization. Hughes and Funkhouser[6] call the growth rates a "mystery". Mann et al.[7] stated that the growth rates "are more dramatic than can be explained by instrumental temperature trends." Since the MBH98 method assumes (p. 780) that proxies follow a linear temperature response, the Graybill-Idso sites should have been disqualified. Instead they were heavily overweighted. An unreported MBH98 calculation[8] excluding these 16 and four other high-altitude sites yielded a PC1 nearly identical to 1c (correlation=0.97).

Secondly, MBH98 made an undisclosed[9] extrapolation of missing early values of a Gaspé tree-ring series, thereby inducing its inclusion in the "AD1400" roster. It is the only such extrapolation. It too exhibits nonlinear 20th century growth and the extrapolation permits this one series to depress early 15th century values of the entire Northern Hemisphere temperature index. A robust methodology would not permit this. The pre-1450 segment has sub-standard signal strength, being based on only 1-2 trees[10] and was not used by the original researchers[11], so use of this interval in MBH98 would be unjustified anyway, quite apart from the missing early values.

Two other proxy series (Twisted Tree and Stahle/SWM) were flagged by Mann et al.[12] as "key indicators", but have minimal effect on the final results.

Figure 1d shows our emulation of the MBH98 northern hemisphere temperature index, successfully replicating the main features (correlation=0.89). Despite our requests, Mann et al. have provided insufficient disclosure to permit exact replication. Figure 1e shows our calculation using conventional PC methods (keeping the North American PC1 and PC2 in the AD1400 roster) and excluding the Gaspé extrapolation. The early 15th century values of the corrected temperature index (1e) exceed 20th century values. There are many other data quality problems in MBH98[13], but the net result of other updates and corrections is similar to Figure 1e.

Using only the proxies available back to AD1400, our emulation of MBH98 yields a goodness of fit "RE" measure of 0.30. The apparent reconstructive skill is spurious. Using conventional PCs, RE falls to -0.03, and excluding the pre-1450 Gaspé data it drops to –1.03.

The MBH98 conclusion of unique 20th century warmth thus depends on undisclosed and unconventional statistical methods, which place maximum weight on data not linearly related to temperature.

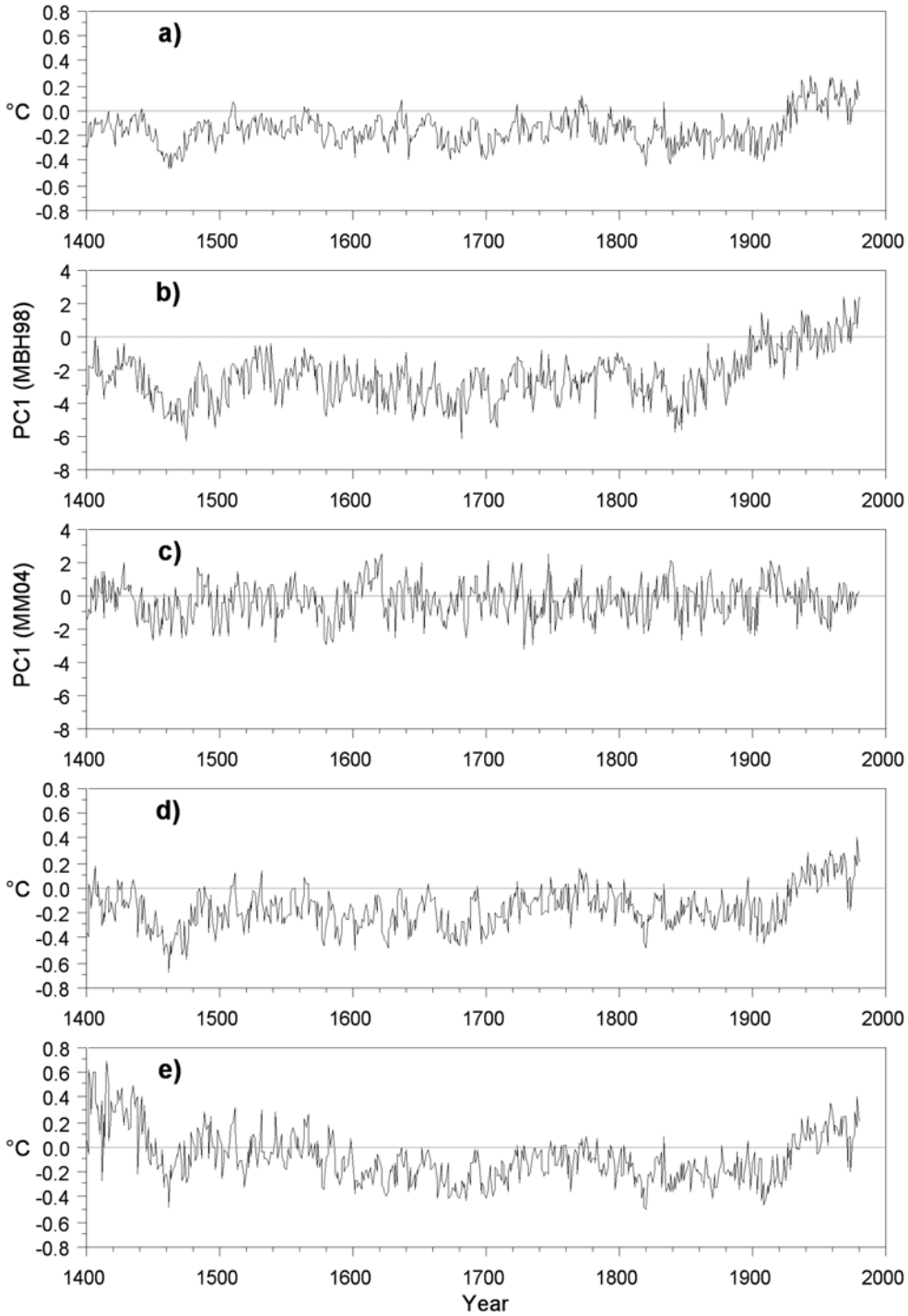

Figure 1. a: Northern Hemisphere temperature index from MBH98. b: North American tree ring PC1 from MBH98. c: same PC1 using conventional software. (b and c normalized to 1902-1980). d: authors' emulation of (a). e: authors' recalculation after corrections noted in text. Methodology for bottom two panels is identical.

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[5] Graybill, D.A., and S.B. Idso, (1993) *Global Biogeochemical Cycles*, 7, 81-95.
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[8] FTP/TREE/ITRDB/NOAMER/BACKTO_1400-CENSORED.
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[11] Jacoby and d'Arrigo, (1989). *Climatic Change* 14, 39-59.
[12] See ref. 3.
[13] McIntyre, S. & McKitrick, R. (2003). *Environment and Energy* 14(6), 751-771; also ref. 9.